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Experimental Study on Bendable Concrete

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ABSTRACT - Bendable Concrete also known as Engineered Cementitious Composites abbreviated as ECC is class of ultra- ductile fiber reinforced cementitious composites, characterized by high ductility and tight crack width control. This material is capable to exhibit considerably enhanced flexibility. An ECC has a strain capacity of more than 3 percent and thus acts more like a ductile metal rather than like a brittle glass. A bendable concrete is reinforced with micromechanically designed polymer fibres. The aim of this study is to investigate the hardened property (i.e. Flexural Test) of ECC by addition of ARGlass fibres in different proportion. The result is a moderately low fiber volume fraction(<2%) composite which shows extensive strain-hardening.

Keywords - : Bendable Concrete, ECC(Engineered Cementitious Composite)s, Deflection,

I. INTRODUCTION

Conventional concretes are almost un-bendable and have a strain capacity of only 0.1 percent making them highly brittle and rigid. This lack of bendability is a major cause of failure under strain and has been a pushing factor in the development of an elegant material namely, Bendable Concrete also known as Engineered Cementitious Composites abbreviated as ECC. This material is capable to exhibit considerably enhanced flexibility. A bendable concrete is reinforced with micromechanically designed polymer fibres.

ECC is made from the same basic ingredients as conventional concrete but with the addition of high- range water reducing (HRWR) agent is required to impart good workability. However, coarse aggregates are not used in ECCs (hence it is a mortar rather than concrete). The powder content of ECC is relatively high. Cementitious materials, such as fly ash, silica fume, blast furnace slag, silica fume etc. may be used in addition to cement to increase the paste content. Additionally, ECC uses low amounts, typically 2% by volume, of short, discontinuous fibres. ECC incorporates super fine silica sand and tiny Polyvinyl Alcohol-fibres covered with a very thin (nano meter thick), slick coating. This surface coating allows the fibre to begin slipping when they are over loaded so they are not fracturing.

This material is capable to exhibit considerably enhanced flexibility. A bendable concrete is reinforced with micromechanically designed polymer fibres. ECC is made from the same basic ingredients as conventional concrete but with the addition of High Range Water Reducing (HRWR) agent is required to impart good workability. However, coarse aggregates are not used in ECC. The compressive strength of ECC is similar to that of normal to high strength concrete. Normal concrete is brittle in nature while ECC is ductile in nature, due to this property; it has wide applications & wide future scope in various. ECC elongates without fracturing, due to the interaction between fibers, sand, and cement working in a matrix that binds everything together within the material. In addition to reinforcing the concrete with fibers that act as ligaments to bond Department of Civil Engineering Project Report 2017-2018 I.C.E.T 2 MG University it more tightly. The design of the cement matrix with special ingredients to make it more compatible with the fibers and to increase flexibility. Where ordinary concrete and fiber- reinforced concrete are designed to resist cracking, ECC is designed to crack only in a carefully controlled manner. The cracks that are formed in ECC are steady state (or flat) cracks. The width of these cracks remains constant regardless of the length.

II. LITERATURE REVIEW

"Engineered Cementitious Composites (ECC)- Material, Structural and Durability Performance". By Victor c.li in the year 2007

Summary

Beyond the peak load, ECC is no different than normal fiber reinforced concrete showing tension softening response the high tensile ductility is of great value in enhancing the ultimate limit state(ULS) in terms of structural load and deformation capacity as well as energy absorption.

Experimental study on commercially available steel and synthetic fibers. By Soutsos et al. In the year 2012

Summary

Flexural stress – deflection relationships have been used to determine: flexural strength, flexural toughness, equivalent flexural strength, and equivalent flexural strength ratio. The flexural toughness of concrete was found to increase considerably when steel and synthetic fibers were used. However, equal dosages of different fibres did not result in specimens with the same flexural toughness.

Experimental study to investigate the flexural behavior of self-compacting concrete By Pajak and Ponikiewski. In the year 2013

Summary

The flexural behavior of SCC appeared to be comparable to NCV, where the increase of fibers volume ratio cause the increase in pre peak and post peak parameters of SCC. Nevertheless, the type of steel fibers influences much this dependency. However, the SCC achieves the maximum crack mouth displacement for lower deflections than NVC.

Experimental study to examining the influence of the paste yield stress and compressive strength on the behaviour of Fibre Reinforced Concrete By Bensaid Boulekbache et al. In the year 2012

Summary

The results show that the shear strength and ductility are affected and have been improved very significantly by the fibre contents, fibre aspect ratio and concrete strength. As the compressive strength and the volume fraction of fibres increase, the shear strength increases. The ductility was much higher for ordinary and self-compacting.

Experimental study on the potential applications of the fiber reinforced engineered cementitious composite. By Jun Zhang et al. in the year 2013

Summary

Composite slab containing both plain concrete and LSECC, with steel bars at the LSECC/concrete interface, and designed construction procedures, it is possible to localize the tensile cracks into the LSECC strip instead of cracking in adjacent concrete slab. The crucial problem that inter facial failure in composite slab was prevented by using reinforcing bars across the interfaces.

Experimental study on Polyolefin fibre-reinforced concrete enhanced with steel-hooked fibres in low proportions. By Albert et. al in the year 2014.

Summary

The result revealed that it is possible to produce a hybrid fibre reinforced self compacting concrete with a combination of hooked steel fibres and macro polyolefin fibres, preserving the high performance fresh properties within the most common self compacting requirements. It should also be noted that the addition of Fibres did not noticeably change the compressive strength, indirect tensile strength or modulus of elasticity of the reference SCC for any of the amounts types or combination of fibres used.

Experiment on bendable concrete. A bendable concrete is reinforced with micro mechanically designed polymer fibers. By Sagar Gadhiya1, T N Patel and Dinesh Shah. in the year 2015

Summary

Conventional concretes are almost un-bendable and have a strain capacity of only 0.1 percent making them highly brittle and rigid. This lack of bendability is a major cause of failure under strain and has been a pushing factor in the development of an elegant material namely, Bendable Concrete also known as Engineered Cementitious Composites abbreviated as ECC. This material is capable to exhibit considerably enhanced flexibility.

Experiment on bendable concrete. By Kallepalli Bindu Madhavi, Mandala Venugopal ,V Rajesh , Kuncheppu Suresh. In the year 2017

Summary

Recron 3S fiber is introduced in the Engineered Cementitious Composite ECC with suitable mix designs. Fibers in the cementitious matrix tend to reinforce the composite under all

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modes of loading and the interaction between the fiber and matrix affects the performance of cement based fiber composite material. Fibers play an important role in bending of concrete. Recron fiber in bendable concrete shows an effective result when compared with conventional concrete. Bendable shows high flexural strength as water cement ratio decrease.

III. OBJECTIVES

- ❑ To obtain appropriate mix design for bendable concrete.
- ❑ To study the different properties of materials in bendable concrete.
- ❑ To select the optimum mix design proportions for the bendable concrete
- ❑ To check the behavior of bendable concrete under compression and flexure strength test.
- ❑ To compare the test results of bendable concrete with conventional concrete.

IV. METHODOLOGY AND MATERIALS

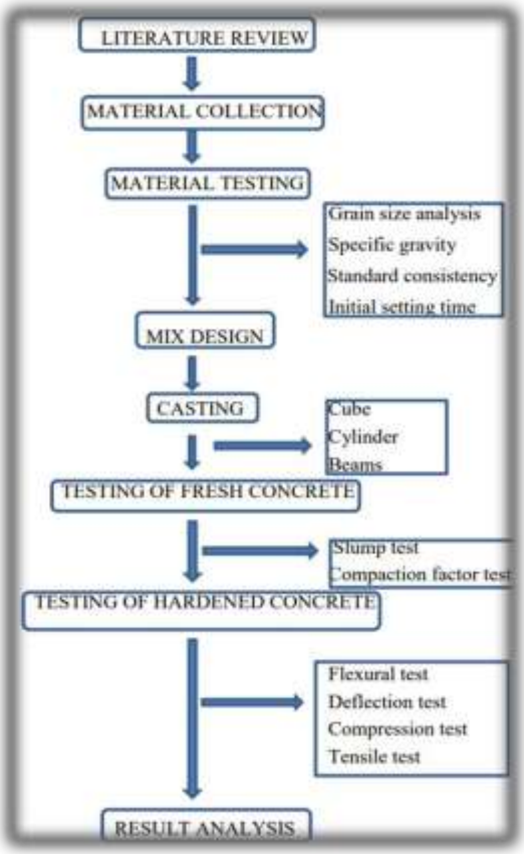

Figure 1: Flow diagram of Methodology

CEMENT: The cement used in the current research was Ordinary Portland cement (OPC). OPC is the general type of cement commonly used around the world, being the basic key ingredient for both concrete and mortar.

SAND: Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. soil containing more than 85% sand-sized particles. Sand is used ingredients of mortar and concrete and for polishing and sandblasting. The weight varies from 1,538 to 1,842 kg/m3, depending on the composition and size of grain. The fine aggregate obtained from river bed of Koel, clear from all sorts of organic impurities was used in this experimental program. The fine aggregate was passing through 4.75 mm sieve and had a specific gravity of 2.68. The grading zone of fine aggregate was zone III as per Indian Standard.

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WATER: Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalis, vegetables or other organic Impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened.

FLY ASH: In RCC construction use of fly ash has been successful in reducing heat generation without loss of strength, increasing ultimate strength beyond 180 days, and providing additional fines for compaction. Replacement levels of primary class fly ash have ranged from 30-75% by solid volume of cementitious material.Class F fly ash is utilized so the acquisition cost is reduced. Only transportation cost is estimated.

SUPER PLASTICIZER: Super plasticizers are improved chemical admixtures over plasticizer with highly effective plasticizing effects on wet concrete. Super plasiticizer result in substantial enhancement in workability at a given water-content ratio. For a constant workability, reduction of a water content up to 30% may be achieved by the use of superplasticizers. Superplasticizers can be used at the higher dosages than conventional plasticizers in the range of 0.5% to 3% by weight of cement.

AR GLASS FIBER: AR Glass fibers also known as an alkali resistance glass fiber. Generally, glass consist of quartz, soda, sodium sulphate, potash, feldspar and a number of refining and dying additive. Glass fibres are useful because of their high ratio of surface area to weight. However, the increased surface area make them much more susceptible to chemical attack. Humidity is an important factor in the tensile strength.

Figure 2: AR Glass Fiber

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